SECTION 1. EXPERIMENTAL BOTANY

DOI https://doi.org/10.30525/978-9934-26-611-9-1

THE EFFECT OF RED AND BLUE LIGHT IRRADIATION ON THE GROWTH AND CULTURAL-MORPHOLOGICAL CHARACTERISTICS OF FUSARIUM SPP.

ВПЛИВ ОПРОМІНЕННЯ ЧЕРВОНОГО ТА СИНЬОГО СВІТЛА НА РІСТ ТА КУЛЬТУРАЛЬНО-МОРФОЛОГІЧНІ ОСОБЛИВОСТІ FUSARIUM SPP.

Batuieva Ye. D.
Doctor of Philosophy,
Senior Lecturer at the Department of Plant and Microorganisms Physiology
V. N. Karazin Kharkiv National University
Kharkiv, Ukraine

Батуєва Є. Д.
доктор філософії з біології,
старший викладач кафедри фізіології та біохімії рослин і мікроорганізмів
Харківський національний університет імені В. Н. Каразіна
м. Харків, Україна

Yastremska K. V.
Master's student at the Department of Plant and Microorganisms Physiology
V. N. Karazin Kharkiv National University
Kharkiv, Ukraine

Ястремська К. В.
магістрант кафедри фізіології та біохімії рослин і мікроорганізмів
Харківський національний університет імені В. Н. Каразіна
м. Харків, Україна

Avksentieva O. O.
Candidate of Biological Sciences,
Associate Professor,
Associate Professor at the Department of Plant and Microorganisms Physiology
V. N. Karazin Kharkiv National University
Kharkiv, Ukraine

Авксентьєва О. О.
кандидат біологічних наук, доцент,
доцент кафедри фізіології та біохімії рослин і мікроорганізмів
Харківський національний університет імені В. Н. Каразіна
м. Харків, Україна

Light regulates most of the basic life processes of fungi: germination, asexual sporulation, formation of sexual fruiting bodies, synthesis of pigments and secondary metabolites, as well as pathogenicity [4]. It is known that the influence of light on the interaction between plants and

mycobiota is realised not only through plant photoreceptors, but also through photosensitive proteins of the micobiota [1,2]. *Fusarium* fungi are common research models due to their phytopathogenic activity and complex secondary metabolism, including carotenoid biosynthesis, the induction of which by light is the best-known photo-regulated process [4, 5]. Photoreceptor proteins are important elements in the perception and transduction of light signalling. It has been established that the *Fusarium* genome contains genes for at least ten photoreceptors: four flavoproteins, one photolyase, two cryptochromes, two rhodopsins, and one phytochrome, that respond to light of different spectra [3]. The photoactivation of different photoreceptor systems, which regulate the processes of growth, development, and secondary metabolism, may vary in *Fusarium* spp. strains of different origin. Therefore, the aim of the study was to investigate the effects of irradiation with monochromatic light of RL (660 nm) and BL (450 nm) on the growth and cultural and morphological characteristics of the virulent strain of the micromycetes *F. oxysporum*.

The study used a virulent strain of *F. oxysporum* (Schltdl), which was isolated into a pure culture from infected seeds of pea of the Mecenat variety (selected by the Yuriev Plant Production Institute of NAAS). The microfungi were cultivated by transferring a 1 mm fragment of mycelium by puncture to the centre of a Petri dish containing 20 ml of dense Czapek-Dox nutrient medium and incubating in the dark at 22±1°C for 21 days. The inoculated Petri dishes were placed in conditions of stationary irradiation with blue (450±10 nm) and red (660±10 nm) selective light using LED matrices. Control cultures of *F. oxysporum* (Schltdl) microfungi grew without irradiation in complete darkness. The diameter of the fungal colonies was measured periodically at intervals of 3-4 days during the cultivation cycle, calculating the growth (mm) and the rate of radial growth of the colonies (mm/day). On day 21, the cultural and morphological characteristics and colour of the mycelium were analysed. The number and size of conidia were assessed at the stage of active sporogenesis using a haemocytometer using light microscopy (Granum R60 Premium Trino). The mean values of three independent series of experiments with the calculated standard error (SE) were compared using Student's t-test, considering the difference to be significant at $p \leq 0.05$.

The results of the analysis of the radial growth of F. oxysporum (Schltdl) colonies under different light conditions showed that the mycelium actively grew during the experiment (21 days) and the colony growth was 63.52-78.73 mm (Table 1). The most effective cultivation of microfungi is under BL irradiation (450 nm). Irradiation with RL (660 nm) significantly inhibits the radial growth of *F. oxysporum.*

Table 1

Effect of photoirradiation with RL (660 nm) and BL (450 nm) on the radial growth of *F. oxysporum* (Schltdl) colonies during 21 days of cultivation (m±SE, n=9)

Cultivation conditions	Absolute growth of colony diameter, mm	Growth rate, mm/day
Control (darkness)	74,71 ± 2,16	3,54 ± 0,16
RL (660 nm)	63,52 ± 2,99*	3,04 ± 0,14*
BL (450 nm)	78,73 ± 3,63*	3,72 ± 0,19*

*) – differences are significant at $p \leq 0.05$

The radial growth rate of colonies during the experiment shows that the growth under all light conditions was within the range of 3.04-3.72 mm/day, i.e. all colonies grew intensively (Table 1). Significant stimulation of this process was observed under cultivation conditions with BL irradiation, while photoirradiation with RL inhibited the growth rate of colonies. The study of the dynamics of radial growth of *F. oxysporum* (Schltdl) colonies during the experiment demonstrates certain patterns of response to photoirradiation (Fig. 1). During the first 7 days of cultivation, no differences were observed between the colony diameter indicators when cultivated in different light conditions and in darkness. From the 11th day of the experiment, a significant effect of BL photoirradiation was observed, leading to a significant increase in the radial growth of colonies under these conditions until the end of the experiment. A significant reaction to the irradiation with RL is observed later, on the 14th day, and manifests itself in the inhibition of radial colony growth. Thus, the effects of RL and BL are opposite and differ in sensitivity, i.e., in the timing of the response.

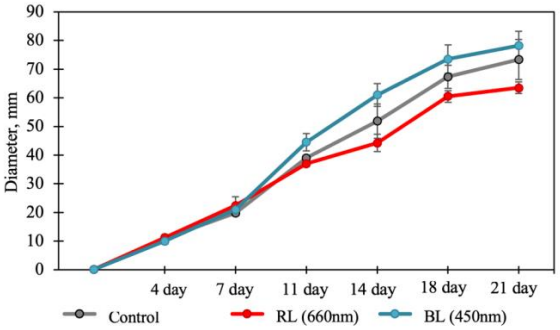

Fig. 1 Dynamics of radial growth of *F. oxysporum* (Schltdl) colonies under the influence of photoirradiation with RL (660 nm) and BL (450 nm)

The cultural and morphological characteristics of *F. oxysporum* (Schltdl) mycelial colonies on nutrient agar (Czapek-Dox Agar) when cultivated under different conditions of stationary photoirradiation and darkness (control) were typical for this species (Fig. 2). All colonies contained airy-fluffy mycelium of pale pink colour of varying intensity.

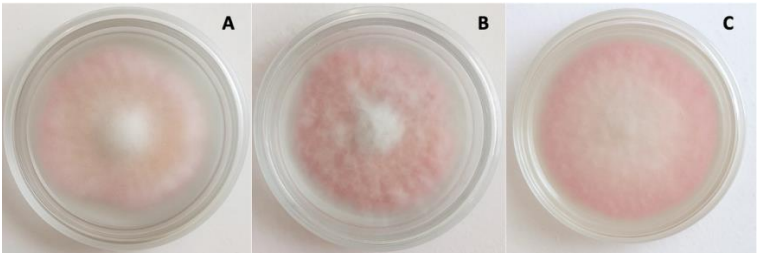

Fig. 2. General view of *F. oxysporum* (Schltdl) mycelium under the influence of selective light irradiation: A – control, B – RL (660 nm), C – BL (450 nm).

The inoculum and the central zone of the colony around it in the control variant and under irradiation of the emergency situation formed a denser and higher mycelium, coloured white (Fig. 2 A, B). Colonies cultured under photoirradiation with BL did not show such characteristics (Fig. 2 C). Photo-exposure significantly stimulated the biosynthesis of carotenoid pigments, which cause the pink colouring of the mycelium, as has also been shown for other species of microfungi [5]. According to the results of the analysis of the sporulation process, photoirradiation with RL inhibits the release of conidia, while the effect of BL is opposite – a significant stimulation of conidia release – an increase of almost 3 times compared to the control (Table 2).

Table 2

Effect of photoirradiation with RL (660 nm) and BL (450 nm) on sporulation (conidiation) activity and conidia size of *F. oxysporum* (Schltdl) (m±SE, n=50)

Cultivation conditions	Number of conidia, pcs. × 10^6/ml	Conidia size, μm	
		Length	Width
Control (darkness)	3,47 ± 0,51	11,98 ± 0,57	2,59 ± 0,12
RL (660 nm)	2,18 ± 0,41*	12,34 ± 0,62	2,80 ± 0,14
BL (450 nm)	11,88 ± 2,97*	17,68 ± 0,88*	2,84 ± 0,14

*) – differences are significant at $p \leq 0.05$

Stationary photoirradiation with RL does not significantly affect the size (length and width) of the crescent-shaped conidia of *F. oxysporum* (Schltdl), while photoirradiation with BL significantly elongates them, leading to a change in morphology. Therefore, based on the results of the studies, it can be concluded that stationary cultivation of the virulent strain *F. oxysporum* (Schltdl) under photoirradiation with RL and BL has the opposite effect.

Bibliography:

1. Adam A. et al. Protein activity of the Fusarium fujikuroi rhodopsins CarO and OpsA and their relation to fungus–plant interaction. *International Journal of Molecular Sciences*. 2018. Vol. 19, № 1. P. 215.

2. Losi A., Gärtner W. A light life together: photosensing in the plant microbiota. *Photochemical & Photobiological Sciences*. 2021. Vol. 20. № 3. P. 451–473.

3. Pardo-Medina J., Limón M. C., Avalos J. Fusarium photoreceptors. *Journal of Fungi*. 2023. Vol. 9, №. 3. P. 319.

4. Fuller K. K., Loros J. J., Dunlap J. C. Fungal photobiology: visible light as a signal for stress, space and time. *Current genetics*. 2015. Vol. 61, № 3. P. 275–288.

5. Vinnikova O. I. Long-lasting effects of red and blue light exposure on the growth of soil fungi. *Acta Biologica Szegediensis*. 2020. Vol. 64 (1). P. 25–35.